Working with Computational Anxiety: Assessing Student Attitudes Towards Learning Computation

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Abstract

We have developed and validated the Computational Modeling in Physics Attitudinal Student Survey (COMPASS), a new tool for characterizing how students think about learning computation. We also made preliminary measurements using several different populations of students learning computation in introductory calculus-based physics courses.

The COMPASS

The COMPASS is a 36-item, five-point Likert scale survey that was designed to be used in courses that teach computation alongside science.

The COMPASS was validated through discussions and interviews with 24 experts in computation, computational physics and computer modeling. Furthermore, wording and statement intent was clarified through interviews with 5 introductory physics students.

COMPASS is valid when used as either a pre- or post-test with students taking introductory calculus-based physics and above.

Scoring the COMPASS

Scores on the COMPASS measure how students' responses align with experts.

Responses are collapsed from a 5-point scale to a 3-point scale (agree to disagree).

Students receive two overall scores and two scores on each dimension: *percent favorable* and *percent unfavorable*.

$$\%\ \text{Favorable} = \frac{\#\ \text{Align with Expert Opinion}}{\#\ \text{Scored Statements}} \times 100$$

$$\%\ \text{Unfavorable} = \frac{\#\ \text{Opposite of Expert Opinion}}{\#\ \text{Scored Statements}} \times 100$$

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Dimensions of the COMPASS

Perceived Ability How confident students feel about using computational models or learning computation

Perceived Utility Evaluate the utility of learning computation for their future work or of computation itself for helping to understand science

Real-World Connections Students' use of computation to their future career or in the "Real World"

Sense-making The effort which students put forth to understand the computational model or the physical model that it describes

Expert Behaviors Contrast what experts do when using or developing computational models to what students might do by performing expert-like actions

Avoiding Novice Behaviors Contrast what experts do when using or developing computational models to what students might do by avoiding novice-like actions

Personal Interest Students own interest for learning computation

Avoiding Rote Is it sufficient to simply memorize details about computation to learn it

Populations Tested

In its validated form, the COMPASS has been given in only one semester before and after instruction to students taking:

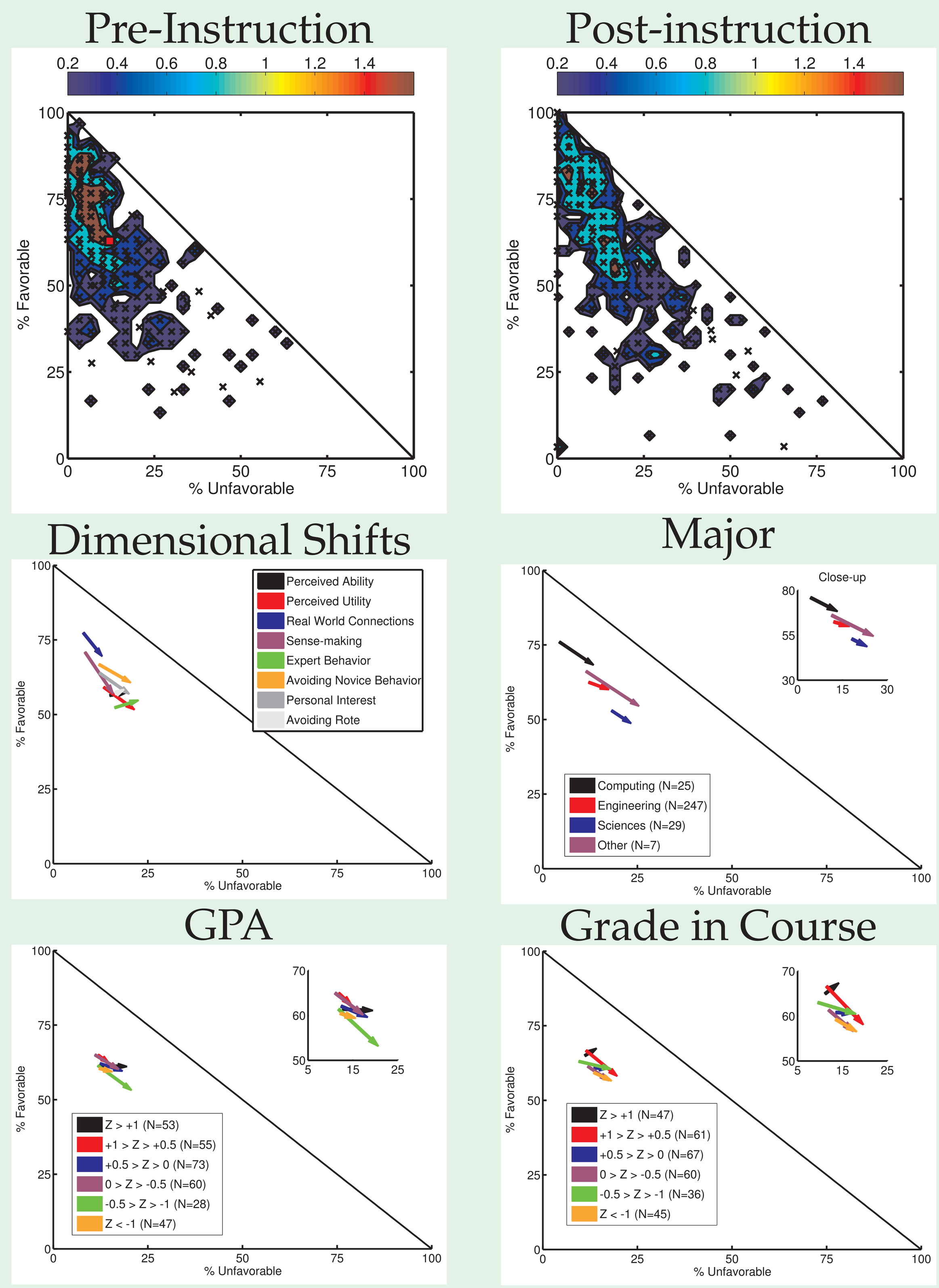
- Intro. Mechanics at Georgia Tech ($N = 316$)
- Intro. E&M at Georgia Tech ($N = 238$)
- Intro. Mechanics at NCSU ($N = 164$)

In all these courses, students used the Matter & Interactions textbook, learning computation in their laboratory sections.

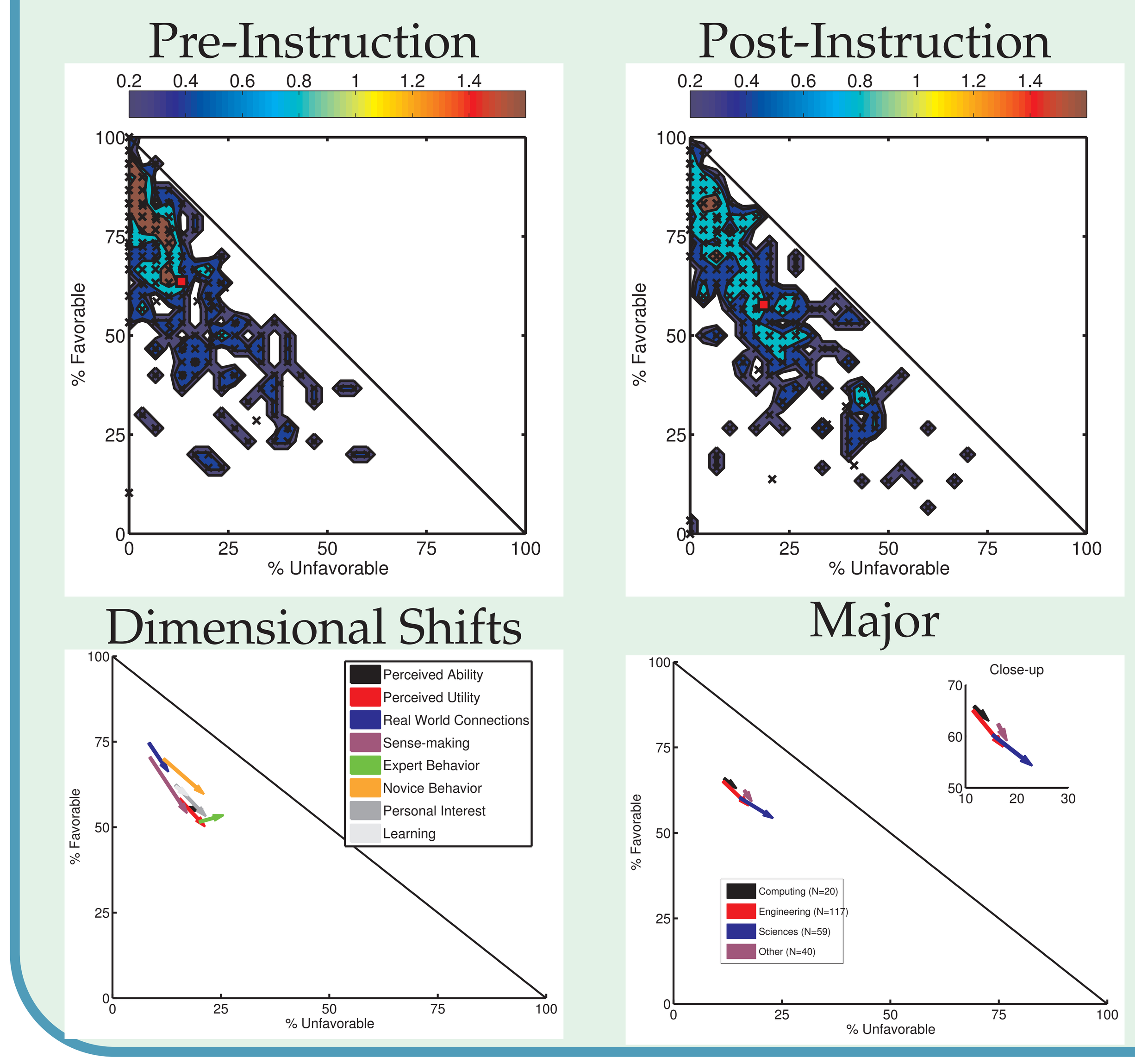
The Georgia Tech mechanics sections also solved a suite of computational homework problems throughout the semester.

Results – Georgia Tech Mech.

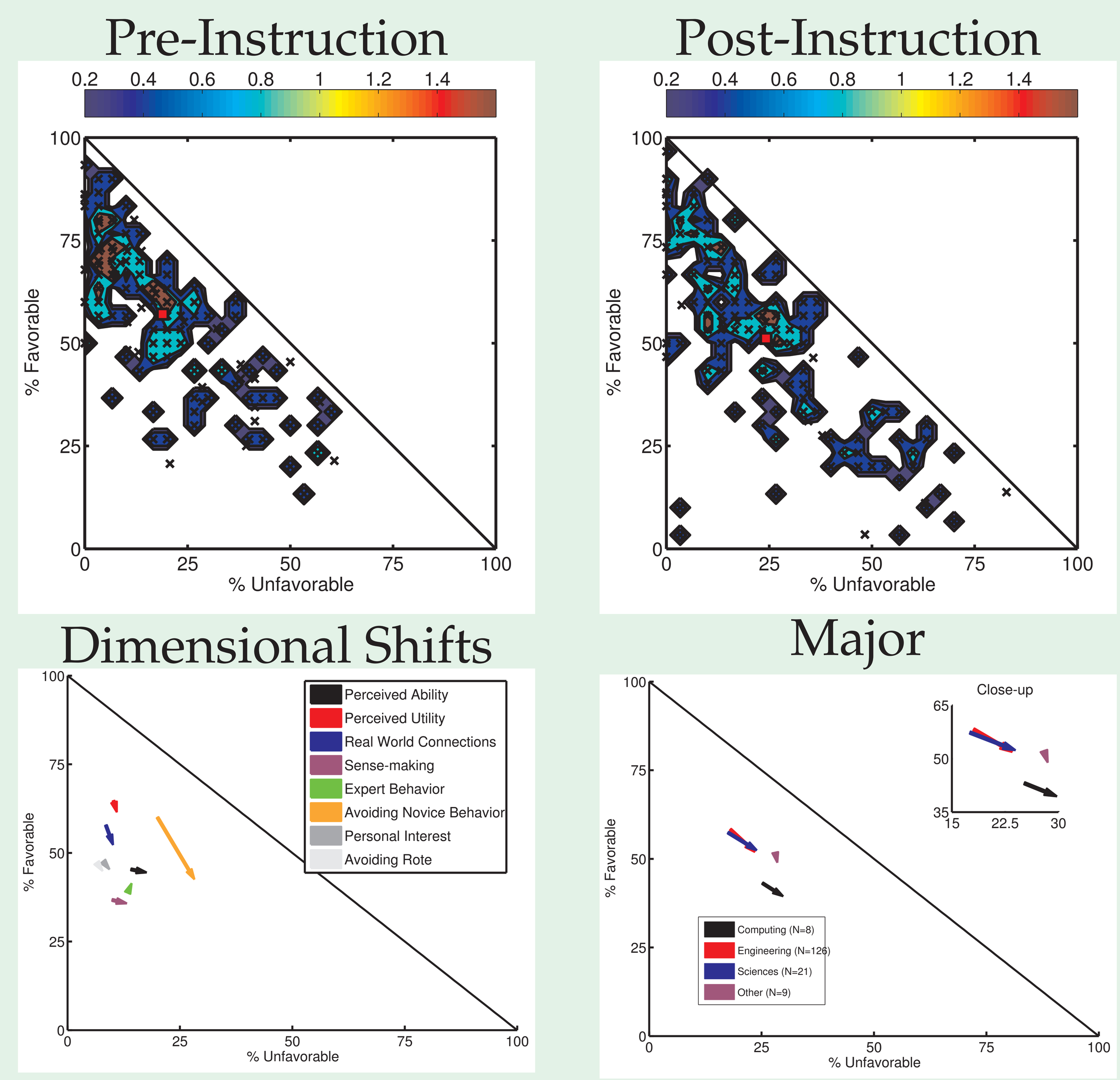
Responses are less favorable on the Post-instruction COMPASS. Choice of major and grade in course are significant influences.



Results – Georgia Tech E&M



Results – NCSU Mech.



Use – Student Success?

Georgia Tech mechanics students who passed a computational modeling evaluation have more favorable pre- and post-test COMPASS scores.

Dimension	Passed PRE	Passed POST	Failed PRE	Failed POST
Overall	66 (2)	61 (3)	58 (3)	55 (4)
Perceived Ability	60 (3)	59 (3)	50 (4)	54 (5)
Perceived Utility	62 (3)	55 (4)	54 (4)	44 (4)
Real-World Connections	79 (3)	72 (4)	74 (4)	64 (5)
Sense-making	77 (3)	58 (4)	67 (4)	54 (6)
Expert Behaviors	56 (3)	57 (4)	47 (4)	51 (5)
Avoiding Novice Behaviors	69 (3)	63 (3)	64 (4)	56 (4)
Personal Interest	66 (3)	60 (4)	61 (4)	49 (6)
Avoiding Rote	59 (4)	61 (4)	54 (5)	53 (5)

Other Possible Uses

- Contrast students in intro. courses with more advanced (but still "novice") students
- Investigate alternative content delivery methods (e.g., experiential, design, etc.)

Future Work

More data must be collected to determine the reliability of the COMPASS. Responses to the COMPASS will be collected at Purdue University and compared to results from Georgia Tech.